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ASEPTIC SURGICAL TECHNIQUE.[1]

MINIMUM REQUIREMENTS FOR ASEPTIC SURGICAL OPERATING IN A HOSPITAL IN WHICH THE PERSONNEL OF THE OPERATING ROOM IS PERMANENT.

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METHODS can best be tested under the conditions indicated by the subject of this paper because they imply that the responsibility rests upon one person at the head of the surgical work, and that he is permanently supported in his efforts by a staff of assistants who are directly responsible to him, and are consequently bound to apply the principles laid down as valid by their chief.

This makes it possible to develop certain definite methods which are applied constantly by responsible persons in a large series of consecutive cases, and if the methods should not be followed by satisfactory results, it is possible to locate the cause of failure, and to change the methods accordingly until they are satisfactory, and to eliminate such members of the personnel as may be found incompetent to carry out the methods contemplated by the plan.

In order to secure the best possible results, such a system must be (1) simple and yet comprehensive; (2) it must be uniform, and (3), above all things, it must be reasonable.

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Simplicity.—Any system which is complicated is certain to contain elements which will not be fully comprehended by some person who may be necessary to carry out some portion of the plan; and if any one point is omitted in a system, the result of the entire system cannot be satisfactory. Moreover, it is correspondingly more difficult to locate the cause of trouble in any given case.

It is true that many most complicated systems have furnished large series of successful results, but the results have in no way excelled those obtained by vastly simpler methods. Of course, so long as the useless complications in any given system are at the same time harmless, the results will be as satisfactory with as without them.

Uniformity.—One of the most important elements in the development of a satisfactory system lies in the uniformity with which it is practised by the chief. If the chief does not uniformly do the same thing in the same manner under the same conditions, it is impossible for his assistants to thoroughly acquire a system. Of course, it is wise to make changes in order to perfect every system, but this should be done only after careful consideration and not in a haphazard manner. In this manner the youngest assistant without responsibility can acquire the principles involved in the system, and as he continues in his service he will be able to carry out his part without doing mischief, because he has seen each step carried out many times before he is called upon for responsible action in the same direction.

Reasonableness.—Surgery is more and more coming to be a very reasonable, logical profession; and in developing a system of aseptic practice, one can count with much greater certainty upon the probability that every one concerned will carry out the details if he is expected to do things which would appeal to a sensible person, than if he is expected to go through an unreasonable routine performance.

The system must provide for every contingency, and each element of the system must be carefully studied before it is established. Conditions differ vastly in different institutions, and it is consequently necessary to adjust each individual system so that it provides for all the conditions involved in any given institution.

There must be a definite responsibility which can be established best by having the chief take the blame for all failures. If the system is carefully planned, and the chief is judicious in the selection of his assistants, failures are to be looked for very rarely, and when they do occur, the indication is usually, barring accidents, of course, that there is some element of the system which requires further perfection.

I will briefly outline the system in use at the Augustana Hospital because we have practically all the conditions implied by the title of this paper, and because the system has been developed by constant effort during a period of fifteen years under the same conditions. The methods have been accumulated by visiting many hospitals in this country and abroad, and by weighing the current literature during the entire period since the introduction of antiseptic surgery. The chief effort has been to simplify the methods, at the same time striving to secure the best results.

Disinfection of the Patient.—Unless there is some special reason in the physical condition of the patient, the following steps are taken in his disinfection previous to performing any operation: He receives a full warm soap and water tub-bath on the day before the operation. For the disinfection of his alimentary canal he receives two ounces of castor oil, in the foam of beer, directly before taking his bath, and a large warm water enema on the morning of the operation, except in case of operations upon the rectum. In these cases the enema is given on the evening before the operation.

On the evening before the operation, the skin over the seat of operation is thoroughly scrubbed with green soap and warm water, then shaved, then scrubbed with strong alcohol; then a moist dressing of gauze saturated with a 3 per cent. carbolic acid solution is placed over the field of operation, over this a large covering of absorbent cotton held in place with a gauze bandage completes the dressing. Just before the operation this dressing is removed and the surface again scrubbed with strong alcohol. For several years we always prepared the skin over the region of the operation immediately before beginning to operate, and found it perfectly satisfactory; but it consumed too much of our time, consequently we now have this done by the surgical nurse on the previous day.

Disinfection of the Operator and Assistants.—The most important precaution taken is to keep the hands out of pus. In dressing suppurating wounds, forceps and rubber gloves are used so as to prevent the hands from touching pus. The operations are performed early in the morning before any one connected with the wounds has made dressings. The fact that it is bad practice to soil one's hands with pus is impressed most forcibly upon every one connected with our work.

Aseptic cases are always operated first, and later those containing pus. In operations upon suppurating cases, rubber gloves are used at the present time; but in former years, by taking the precautions indicated above, practically no infections took place, although no gloves were used.

I operate upon alternate days, so that on the intervening days the same precautions can be taken in dressing the wounds, —no suppurating wounds being dressed until all clean wounds have been finished.

Every evening before retiring, the surgeon and all the assistants scrub their hands with the same care that is employed in disinfection before an operation. The assistant who has charge of the patients who are primarily aseptic has nothing to do with the patients who are not aseptic primarily from the character of their disease and *vice versa.*

The aseptic assistant prepares a table of all the cases which come under his care during this portion of his service, upon which he notes the names of the patients, the age, diagnosis, duration of disease, operation, number and dates of dressings, the result as regards the wound, the date of admission, and the date of discharge. This record is filled out every evening, and acts as a remarkable stimulant to careful and conscientious work; and the practical results are exceedingly satisfactory.

I speak of these conditions first because they go to form an aseptic conscience in those connected with surgical work, and upon this depends the condition of the wounds rather than upon any special method.

At the present time we wash our hands in an ordinary deep porcelain basinful of warm water, using green soap with a moderately stiff brush; then we carefully cleanse the finger-nails with the point of a dull scalpel; then we scrub them once more with a brush, and then with a piece of sterilized gauze in the deep basin, because the gauze seems to rub off all the loose epithelium more perfectly than a brush; then we wash off the soap under the faucet in a stream of warm, boiled water; then we wash in 1–2000 corrosive sublimate solution for a few moments and then with strong commercial alcohol. I have varied this plan from time to time experimentally, and have found that after washing carefully with soap and warm water and cleaning the nails and washing once more thoroughly our wounds remained aseptic. The same was true if we supplemented this by washing with a sublimate solution, with or without alcohol, or by washing with the alcohol without the sublimate solution. There is one point, however, that I insist upon, viz., that every one connected with the operation have a smooth, unbroken skin upon his hands, or wear rubber gloves. Both of the assistants and the surgical nurse wear rubber gloves during all operations, while I wear gloves only in operations in the presence of pus.

We are careful not to breathe or speak into the wound. Every one connected with the operation is constantly on guard to prevent accidental infection of anything which may touch the wound. One nurse alone touches anything coming in contact with the wound, her assistant does anything else that may be necessary.

Disinfection of Instruments.—All instruments, except knives, are boiled for half an hour in a solution of a tablespoonful of baking soda to the quart of water before they are put away after operations, and again before they are used. The knives are washed carefully with water and then rubbed with pads of sterilized cotton, saturated with alcohol, before and after using.

Disinfection of Silk, Silkworm Gut, Horsehair, Drainage Tubes, and Brushes.—This is accomplished by boiling in water for one hour, and preservation in 5 per cent. carbolic acid in water, or in strong commercial alcohol until used.

Catgut is prepared by immersing in sulphuric ether for one month, then for one month in strong commercial alcohol in which one grain of corrosive sublimate to the ounce has been dissolved, the solution being renewed once during this time. It is then preserved indefinitely in a solution of one part of sterilized iodoform, five parts of ether, and fourteen parts strong commercial alcohol. It is never handled by any one except my chief assistant and myself. It is never placed in water. This catgut will last seven to ten days in tissues, according to the size used. It is used for all ligatures both in the peritoneal cavity and elsewhere, and for all buried sutures except in herniæ and in the suturing of bones. For these purposes we employ a chromicized catgut lasting from twenty to thirty days, according to size. This is prepared after the following formula: The catgut is immersed in ether for one month, then in a solution prepared in the following manner: Dissolve one ounce of chromic acid in five ounces of water and add to this one quart of pure glycerin. Immerse the catgut in this solution for seventy-two hours, then wind on wooden boards or ground edged slides, such as are used for mounting specimens for microscopic examination, and place in a solution of one part carbolic acid in five parts of glycerin for two weeks, then preserve indefinitely in the iodoform-ether-alcohol solution described above. It is important to dissolve the chromic acid in water before adding the glycerin, in order to prevent an explosion. The catgut prepared by these methods is strong, pliable, slightly antiseptic on account of the iodoform absorbed, and it is invariably sterile. We are careful, above all things connected with the use of catgut, never to draw our stitches too tightly, for fear of causing pressure necrosis.

Disinfection of Dressings.—All dressings are disinfected in a steam sterilizer, two hours being given for steaming and one hour for drying. The same treatment is given to aprons, sheets, and towels.

Disinfection of Everything coming directly in Contact with Wounds.—The basins, instrument pans, jars for dressings, etc., are boiled in soda and water for one hour, then wrapped up in sterilized sheets until used. The tables are scrubbed with soap and water and then with 1–1000 corrosive sublimate in water. They are always covered with a double sterilized sheet when in use. The ordinary pads of cotton and of gauze, sterilized in a steam sterilizer, are used in place of sponges in all operations.

Drainage.—Drainage is always used in very large wounds, such as breast amputations with removal of pectoralis major and minor muscles and axillary glands, also in thigh amputations, usually only for two to four days, never in herniotomies, except for strangulated hernia complicated with gangrene, nor in small clean wounds. The ordinary perforated rubber tube is employed.

It is always used in wounds which are primarily septic. In abdominal surgery we drain acute appendicitis cases if perforation or abscess formation has taken place. We always drain in gall-bladder operations and in suprapubic cystotomy; in pyosalpinx only if there is leakage of pus during the operation. Tubercular joints are tamponed with iodoform gauze. In empyema of the chest we always carry two drains through the cavity, resecting one or more ribs behind and making an opening between the ribs in front.

Whenever there is any doubt as to the aseptic condition of a wound, we drain. We have found the use of an ordinary leather punch very convenient for making the necessary perforations in rubber tubing.

In the abdominal cavity we use glass tubes open at the end, having a number of small perforations towards the lower end. A strand of gauze is carried to the bottom of the tube to act as a capillary drain. A piece of iodoform gauze folded about four double is placed over the glass tube, and the latter with this covering carried down to the point to be drained. In operations upon the pelvic organs, it is carried to the bottom of the cul-de-sac of Douglas.

In removing gall-stones from the common duct, a rubber drainage tube is fastened down upon the opening by means of an unchromicized catgut stitch, and a strand of iodoform gauze is sutured down upon the duct, above and below the opening in the same manner. The same method is employed to drain the gall-bladder after removing gall-stones in cases in which the organ is shrunken and cannot be attached to the peritoneum. This method, which was originated by Dr. Mayo, of Rochester, Minnesota, has been employed in many cases, and makes the otherwise serious operation of choledochotomy practically safe. This method is of such extraordinary value that I wish to emphasize it especially.

Irrigation.—We practically never use irrigation during operations, either in the abdominal cavity or elsewhere.

During the early days of my surgical work as an assistant, I observed that wounds in abdominal section healed more smoothly than in any other operations, and the only real difference in the treatment observable was the fact that no irrigation was used in connection with the former wounds, while it was invariably employed in others. I consequently applied the same plan of treatment to all wounds as early as 1889, and I have since constantly operated dry in clean cases, and since a number of years also in cases containing pus. We have treated wounds in circumscribed tubercular lesions by applying strong compound tincture of iodine, and then sponging the area with moist gauze sponges before tamponing with iodoform gauze or before closing with sutures. These wounds have progressed well; but I do not feel convinced that the iodine has been responsible for this fact.

In tuberculosis of the joints we have applied strong carbolic acid to the exposed surfaces of the bones for two minutes, and have then washed these parts thoroughly with strong alcohol until all of the carbolic acid seemed removed.

I am convinced that irrigation is rarely of any real benefit, and that it is frequently harmful in carrying septic material to portions which might have otherwise escaped infection.

In the treatment of wounds which come into the hospital in a septic condition, we sometimes employ constant irrigation with normal salt solution.

My observations have convinced me that it is an exceedingly simple matter to obtain primary union almost invariably if one has a reasonable system, *i.e.*, a system which keeps the attention of operator, assistants, and nurses constantly on guard to prevent accidental contamination.

Whenever some new method is on trial in any hospital or clinic every one is interested, and, consequently, accidental contamination is not likely to occur. It is for this reason that the various new methods are so successful in the hands of their originators.

In having each successive assistant make observations every day throughout his service, we accomplish a very similar condition, because any case of even the slightest infection will be investigated, and all the conditions will be observed which might spoil the young man's comparative record.

Contact Infection.—My observations have convinced me that the only form of infection which must be considered in surgery is contact infection. This is due to the introduction into the wound of septic material from unclean hands, instruments, sponges, or dressings, or from speaking or breathing into the wound.

It is such an easy matter to make instruments, sponges, sutures, and ligatures aseptic that there only remain the hands to account for. These can be made clean without difficulty and kept clean with proper attention, but it is this part of the system which is more frequently lame than any other. Everything that is to come in contact with the wound, the hands included, is usually clean when the operation is begun, but it is quite another matter to keep these clean throughout the operation, unless every one connected with the operation learns to concentrate his attention upon the work at hand.

In this, again, simplicity is of great importance. The fewer persons who can infect the wound, *i.e.*, the fewer persons who come in contact with anything which in turn comes in contact with the wound, the less are the chances of one of these coming in contact with something which may not be aseptic and then again with the wound.

It is consequently best to have as few assistants directly connected with the operation as possible. In my own work, I alone touch the wound with my hands, and that as little as possible; my first assistant uses hæmostatic forceps and sponges, and the second assistant makes the field of operation as accessible as possible by the careful use of retractors. I handle the instruments myself, and there is but one nurse connected with the operation, and she handles the sponges, drainage tubes, dressings, as well as the sterile sheets, towels, and basins. The same nurse has assisted me in more than 5000 operations, and the same is true of my chief assistant.

Choice of Assistants.—The assistants are graded in the following manner: One chief assistant, three second assistants, and six third assistants.

The third assistants are chosen from the graduating classes of the medical schools and serve for a period of four months. From these the second assistants are chosen. The two from the year's list of eighteen who show the best practical qualifications receive the appointment of second assistants, their service being for a further period of eighteen months. Once in three years, an assistant who has shown during his previous services as second and third assistant that he is especially fitted to become a surgeon is chosen for chief assistant. Each second assistant has two third assistants to aid him in all of his duties. The latter have no responsibilities, however, and never come directly in contact with wounds.

The surgical head nurse is selected for her especial fitness for the work. She receives a suitable salary and remains in her position permanently. She prepares all the dressings, sutures, and ligature material, sterilizes the instruments, supervises the preparation of the operating-room and the patient on the day previous to the operation. She has three assistants, who are undergraduate nurses, whom she instructs, but who do not come directly in contact with anything which comes into contact with the wound.